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NITROSAMINES

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NITROSAMINES

VOLUME 5

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INTRODUCTION

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Coverage of the subject has been restricted to that of Food Science and Technology Abstracts, which covers over 1200 of the important food journals, patents from 20 countries and books published world-wide. Every effort is made to include all significant references, but editorial discretion is used on the many articles of borderline interest. If the reader particularly needs an exhaustive search of the subject, we will be pleased to provide any other references that we have available. We would in any case encourage readers to write or telephone us with any comments or queries they may have.

J. NEWTON
ASSISTANT EDITOR

1 A 31
Gas chromatographic determination of volatile nitrosamines in foods.
Essigmann, J. M.; Issenberg, P.
Journal of Food Science 37 (5) 684-688 (1972) [11 ref. En] [Dept. of Nutr. & Food Sci., Massachusetts Inst. of Tech., Cambridge, 02139, USA]

Methods are presented for determination of certain volatile nitrosamines which have been reported to occur in foods. Nitrosamines were removed from foods using a Likens-Nickerson extractor; 60% of added dimethylnitrosamine and 70% of added diethylnitrosamine were recovered from 10 ng/g aqueous solutions. Potential gas chromatographic (GC) interferences were removed from the extract by a simple acid extraction step and, when needed, by liquid column chromatography. Dilute solutions containing nitrosamines were analyzed directly with a GC solvent stripping technique. Nitrosamines were detected with a Coulson electrolytic conductivity detector operated in the pyrolytic mode and with a flame ionization detector. Sensitivities of these detectors are compared for selected volatile alkyl and heterocyclic nitrosamines of potential significance in foods. The specificity of the Coulson detector is demonstrated for analysis of extracts of smoked fish and a number of processed meats. Additional clean-up of concentrates from foods is required to insure unambiguous identification of nitrosamines by combined GC-mass spectrometry. IFT

1 C 22
The use of a molecular separator in the determination of trace constituents by combined gas chromatography and mass spectrometry.
Gough, T. A.; Webb, K. S.
Journal of Chromatography 64 (2) 201-210 (1972) [10 ref. En] [Lab. of the Govt. Chemist, Stamford Street, London SE1 9NQ, UK]

A method combining gas chromatography and MS for the detection and estimation of traces of volatile nitrosamines in extracts is described. A membrane separator is used; and details of its construction and performance are given. By peak matching against a reference compound, a detection limit of 2 mg/l. of the nitrosamines is achieved. By incorporating a peak cutting system into the gas chromatograph the detection limit is lowered to 0.2 mg/l., which represents a limit of 0.2 µg/kg on the original material. AS

1 C 23
Estimation of steam-volatile N-nitrosamines in foods at the 1 µg/kg level.
Crosby, N. T.; Foreman, J. K.; Palframan, J. F.; Sawyer, R.
0612bh 238 (5363) 342-343 (1972) [19 ref. En]

A survey was made of nitrite and volatile nitrosamine levels using the gas chromatography and MS method of Gough & Webb (see preceding abstr.) ; N-nitroso derivatives of dimethylamine (DMN), methylethylamine (DEN), dipropylamine, dibutylamine, pyrrolidine (PYR) and piperdine were estimated in a selection of randomly purchased foods. Of 24 samples of bacon, 6 contained DMN and 9 contained PYR at levels ≥1 µg/kg; in 16 samples, nitrite was in the range 2 to 60 mg/kg. Results tabulated for 35 samples of fresh, processed and cooked fish showed that 15 contained ≥1 µg DMN/kg; traces (2 mg/kg) of nitrite were found in 11 samples. 6 of 12 samples of different varieties of cheese contained ≥1 µg DMN/kg but none contained DEN and all contained <2 mg nitrite/kg. Small amounts of nitrosamines (≤4 µg/kg) were also detected in Hungarian salami, Danish chopped pork and luncheon meat but not in used frying oil or brined spinach. BEPC

1 S 17
Dimethylnitrosamine in frankfurters.
Wasserman, A. E.; Fiddler, W.; Doerr, R. C.; Osman, S. F.; Dooley, C. J.
Food and Cosmetics Toxicology 10 (5) 681-684 (1972) [8 ref. En] [E. Regional Res. Lab., Philadelphia, Pennsylvania 19118, USA]

Samples of frankfurters from 8 large producers were analysed for N,N-dimethylnitrosamine (DMNA), using gas chromatography, with an alkali-flame ionization detector for quantitative analysis and a mass spectrometer for confirmation. Only trace levels of a compound that was apparently DMNA were found in the products of 5 manufacturers. In one further sample a somewhat higher level of a compound presumed to be DMNA was found but again this could not be confirmed. 2 samples of frankfurters containing 84 and 11 µg DMNA/kg respectively, were found among 22 samples from one producer, and one sample out of 12 from another producer contained 48 µg DMNA/kg. These were confirmed. High sodium nitrite values found in the frankfurters from one manufacturer could not be correlated with nitrosamine formation. AS

1 S 57
Effect of sodium nitrite concentration on N-nitrosodimethylamine formation in frankfurters.
Fiddler, W.; Piotrowski, E. G.; Pensabene, J. W.; Doerr, R. C.; Wasserman, A. E.
Journal of Food Science 37 (5) 668-670 (1972) [16 ref. En] [USDA E. Regional Res. Lab., E. Marketing & Nutr. Res. Div., Philadelphia, Pennsylvania 19118, USA]

The effect of nitrite concentration on N-nitrosodimethylamine (DMNA) formation using frankfurter emulsion was investigated. Sodium nitrite was usually added to the emulsion to give levels of 150, 750, 1050, 1500 and 2500 mg/kg of meat. The frankfurters were cooked with light smoke for either 2 or 4 h. DMNA was determined in all samples by GLC with an alkali flame ionization detector and confirmed by GLC-MS when sufficient amounts were present. Residual nitrite analysis indicated that about one-half of the sodium nitrite added was still present after

processing. 19 μg DMNA per kg meat was found in frankfurters that contained 2500 mg sodium nitrite per kg of meat and processed for 2 h. Indications of DMNA in levels of 3-14 μg/kg meat were obtained with frankfurters containing 750-1500 mg sodium nitrite per kg meat and processed for either 2 or 4 h depending on the nitrite level. There appeared to be some tendency for an increase in DMNA formation on increasing processing time. IFT

2 C 28
[Food hygiene aspects of nitrosamine compounds.] [Review]
Ishidate, M.
Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] **12** (3) 149-151 (1971) [7 ref. Ja] [Pharmaceutical Assoc., Ginza 6-8-7, Chuo-ku, Tokyo, Japan]

2 C 42
A gas-liquid chromatographic procedure for the detection of volatile N-nitrosamines at the ten parts per billion level in foodstuffs after conversion to their corresponding nitramines.
Telling, G. M.
Journal of Chromatography **73** (1) 79-87 (1972) [16 ref. En] [Unilever Res. Lab., Colworth House, Sharnbrook, Bedford, UK]

A procedure is described which is capable of detecting volatile N-nitrosamines in foodstuffs at the 10 parts/billion (billion = 10^9) level or better. The method is based on vacuum distillation, clean-up on an alumina column, oxidation with peroxytrifluoroacetic acid, further clean-up on a mixed magnesium oxide/alumina column and determination by electron capture GLC. The method has been evaluated for a range of N-nitrosamines added to a variety of foodstuffs (e.g. spinach, processed meat). AS

2 C 57
[Carcinogenic nitrosamines from simple aliphatic tertiary amines and nitrite.] Cancerogene Nitrosamine aus einfachen aliphatischen tertiären Aminen und Nitrit.
Schweinsberg, F.; Sander, J.
Hoppe-Seyler's Zeitschrift für Physiologische Chemie **353** (11) 1671-1676 (1972) [27 ref. De, en] [Hygiene-Inst., Univ., D-74 Tübingen, Federal Republic of Germany]

Reaction of nitrous acid with tertiary amines yields nitrosamines after dealkylation to secondary amines. Nitrosation of trimethyl- and triethylamine produced best yields at pH 3.3, as with secondary amines. Amount of diethylnitrosamine found in nitrosation of triethylamine at 100°C was 200 times smaller than in the reaction with diethylamine. Addition of diethylamine and nitrite to diet of rats did not produce tumours. It was therefore expected and shown that addition of 0.5% triethylamine and 0.5% nitrite to diet of rats did not cause any toxic effects. These experiments were started 1 yr ago; no tumours have been observed so far. Nitrosation of simple aliphatic tertiary amines in dilute aqueous solutions at 100°C obeys the following kinetic equation: rate = k × [amine] × [nitrite]^3. Concn. of amine and nitrite that occur in the environment are normally much smaller than concn. used in animal experiments. Because of the great dependence of the reaction on nitrite concn. only minute amounts of carcinogenic nitrosamines will be formed in vivo or under conditions that correspond to cooking of food. It is therefore doubtful wheather amounts of nitrosamines formed with these low concn. are sufficient for induction of tumours. AS

3 A 142
Report, 1971.
UK, Government Chemist
Report of the Government Chemist 176pp. SBN 11 470549 6 (1972) [En] London, UK, H. M. Stationery Office. Price £1.25

This report includes further development work on a GLC method for estimating vitamin D in National Dried Milk, using dry-column chromatography for the removal of sterols. In a survey of 100 food samples, dimethylnitrosamine was detected in 6 of 13 cheese samples. The range of foodstuffs surveyed for pesticide residues has been further reduced. Mean values (mg/kg) of organochlorine pesticides in Australian and New Zealand butters in 1971 were respectively: total BHC isomers, 0.01 and <0.01; dieldrin, <0.01 and <0.01; DDT + DDE + TDE, 0.04 and 0.10. JMD

4 C 94
Nitrites, nitrates, and nitrosamines in food - a dilemma.
USA, Institute of Food Technologists, Expert Panel on Food Safety & Nutrition
Journal of Food Science **37** (6) 989-992 (1972) [15 ref. En]

Attention is currently being focused on nitrosamines, a group of chemicals shown to be carcinogenic, which can be formed in food products as a reaction between nitrites and certain amines. A general review of nitrite and nitrate toxicity studies is presented emphasizing the difficulty encountered in analysing for nitrosamines. In answer to the question why not eliminate amines and nitrites from foods, suggests acquiring more data as quickly as possible so a sensible, considered judgment can be made. IFT

4 E 143
Research '73 stresses applications.
Hannigan, K. J.
Food Engineering **45** (1) 52-53 (1973) [En]

Research projects underway at USDA and Fishery Service laboratories are briefly described. Emphasis in 1973 is likely to be on applying current research rather than new projects. Projects include work on poultry meat, pork sausages, cottonseed and peanut protein, rice milling, sweet potatoes, soybean oils, oat protein, dry-milled corn germ flour, corn and corn germ protein, dairy products with reduced lactose content, high polyunsaturated fat-containing meat, nitrosamines in meat, fish processing, new fish for consumption, fish aquaculture, and fish in hamburgers. JN

4 P 460
Examination of nonfat dry milk for the presence of nitrosamines.
Reineccius, G. A.; Coulter, S. T.
Journal of Dairy Science **55** (11) 1574-1576 (1972) [11 ref. En] [Dept. of Food Sci. & Nutr., Univ. of Minnesota, St. Paul, 55101, USA]

Dry skim-milk prepared using indirect steam heat and direct gas firing was examined for detectable levels of nitrosamines. The addition of 10 ng nitrosamine/g dry skim-milk could be detected by oxidation of the extracted nitrosamine to nitrosamines and detection by electron capture gas chromatography. No volatile nitrosamines were found in freshly prepared or stored (30 days) dried milk that had been produced by indirect steam heat or by direct gas firing. **AS**

5 A 239
The determination of steam-volatile N-nitrosamines in foodstuffs by formation of electron-capturing derivatives from electrochemically derived amines.
Alliston, T. G.; Cox, G. B.; Kirk, R. S.
Analyst **97** (1160) 915-920 (1972) [15 ref. En] [Dept. of Trade and Ind., Lab. of the Government Chemist, Cornwall House, Stamford Street, London, SE1 9NQ, UK]

A method for the determination of 6 steam-volatile N-nitrosamines in a range of foodstuffs is described. N-Nitrosamines are isolated by steam distillation and are subjected to controlled-potential electrochemical reduction. The amines thus produced are converted into polyfluorinated amides, which are analysed by gas chromatography by means of electron-capture detection. Sensitivities of 1 µg/kg of original foodstuff are attained for all the N-nitrosamines studied. Low levels of some N-nitrosamines have been detected in several foodstuffs, some of which had not been treated with nitrate-nitrite preservatives. **AS**

5 B 51
[Nitrosamines in foods. I. In vitro and in vivo formation of dimethylnitrosamine.]
Sakai, A.; Tanimura, A.
Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] **12** (3) 170-176 (1971) [8 ref. Ja, en] [Nat. Inst. of Hyg. Sci., Kamiyoga 1-chome, Setagaya-ku, Tokyo, Japan]

The formation of nitrosamine in foods is presumed to occur by the addition of nitrite as colour fixative or preservative to marine fishes or roes which contain high concn. of secondary amines such as dimethylamine (DMA) or dimethylnitrosamine (DMNA). The optimum pH for the production of DMNA in buffer solution was near 3.6. Thirty min. after oral administration of 1000 mg $NaNO_2$ and 500 mg DMA.HCl to rabbits, 5 mg of DMNA was detected in the stomach. The possibility of the formation of nitrosamines in the human stomach by the uptake of nitrites as food additive is discussed. **TM**

5 B 52
[Nitrosamines in foods. II. Colorimetric determination of secondary amines and nitrosamines.]
Ito, Y.; Tanimura, A.
Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] **12** (3) 177-184 (1971) [10 ref. Ja, en]

The precursors of nitrosamine known to be potent carcinogenic substances, have been identified as nitrites and secondary amines. For the purpose of investigating the toxicity of nitrosamines in foods, the distribution of secondary amines in foods, was investigated, and a determination method employing a modification of the naphthylamine colorimetric method reported by Uno was established. **TM**

5 B 54
[Nitrosamines in foods. IV. Distribution of secondary amines in foods.]
Kawamura, T.; Sakai, K.; Miyazawa, F.; Wada, H.; Ito, Y.; Tanimura, A.
Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] **12** (3) 192-197 (1971) [8 ref. Ja, en]

Distribution and amounts of secondary amines in foods, especially in Japanese foods, were described. Nitrosamines in foods were also analysed. Fishes and roes contained large quantities of secondary amines, i.e. dimethylamine and diethylamine, and the amounts of these amines in roasted fish increased remarkably. Only traces of secondary amines were found in meats, even in roasted meats. Nitrosamine was not detected in any of the analysed foods. **TM**

5 C 116
[Interrelationships between nitrate, nitrite and carcinogenic N-nitroso compounds. I. Nitrate, nitrite and nitrosable amino compounds in food and drugs, chemistry of N-nitroso compounds. II. The generation of nitrosamines and nitrosamides in humans, animals and foodstuffs.]
Wechselbeziehungen zwischen Nitrat, Nitrit und kanzerogenen N-Nitrosoverbindungen. I. Nitrat, Nitrit und nitrosierbare Aminoverbindungen der Nahrungs-, Genuss- und Arzneimittel, Chemie der N-Nitrosoverbindungen. II. Untersuchungen über die Entstehung von Nitrosaminen und Nitrosamiden im Menschen, im Tier und in Nahrungsmitteln. [Review]
Sander, J.; Schweinsberg, F.
Zentralblatt für Bakteriologie, Parasitenkunde, Infektionskrankheiten und Hygiene, IB **156** (4/5) 299-320; 321-340 (1972) [many ref. De, en] [Hygiene Inst., Univ., Tübingen, Federal Republic of Germany]

5 S 580
Nitrosopyrrolidine and dimethylnitrosamine in bacon.
Sen, N. P.; Donaldson, B.; Iyengar, J. R.; Panalaks, T.
Nature, UK **241** (5390) 473-474 (1973) [12 ref. En] [Res. Lab. (Foods), Health Protection Branch, Tunney's Pasture, Ottawa 3, Canada]

Evidence is presented for the presence of both dimethylnitrosamine (DMN) and nitrosopyrrolidine (NPy) in bacon. 16 samples of bacon (both fried and unfried), 5 of baby foods containing bacon as one of the ingredients, and 6 of other meat products were analysed. 8 samples gave a positive test for either DMN or NPy. None of the raw bacon contained any detectable amount of NPy but one contained about 0.033 ppm DMN. Because of its high volatability the level of DMN in this sample fell to about 0.004 ppm on frying. From these limited data it is suggested that NPy is formed during frying. As NPy is also fat-soluble the major portion would be expected in the cooked fat, in one sample about 70% of the total NPy was detected in the cooked fat. Further research is necessary to establish the reactions responsible for the formation of NPy in cooked bacon. AA

5 T 235
[Reactions of food additives with foods components, in relation to nitrites.] [Review]
Tanimura, A.
Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] **12** (4) 277-281 (1971) [Ja] [Nat. Inst. of Hyg. Sci., Kamiyoga 1-chome, Setagaya-ku, Tokyo, Japan]

Effects of nitrites on food preservation and their toxicity, possible reaction to form nitrosamines from secondary amines and nitrates in foods, possibility of the formation of nitrosamines in the animal stomach, and the distribution of these toxic substances in foods are discussed. TM

6 C 140
[Formation of nitrosamines from lecithin and nitrite.] Bildung von Nitrosaminen aus Lecithin und Nitrit.
Möhler, K.; Hallermayer, E.
Zeitschrift für Lebensmittel-Untersuchung und -Forschung **151** (1) 52-53 (1973) [3 ref. De, en] [Deutsche Forschungsanstalt für Lebensmittelchemie, München, Federal Republic of Germany]

Volatile carcinogenic N-nitrosamines in ppm quantities are formed by boiling lecithin and nitrite in buffer solutions in the pH range 3.5-7. AS

6 C 141
[The nitrosamines, carcinogenic contaminants of foods.] [Review]
Lederer, J.
Cahiers de Nutrition et de Dietetique **7** (4) 281-286 (1972) [48 ref. Fr]

This review discusses the carcinogenic effects of nitrosamines, the formation of nitrosamines during digestion of foods by man and animals, and the presence of precursors of nitrosamines in foodstuffs. Evidence for the presence of nitrosamines in flour, alcoholic beverages, milk products, fish, meat and vegetables is summarized. MEG

6 C 157
Factors affecting dimethylnitrosamine formation from simple precursors by rat intestinal bacteria.
Klubes, P.; Cerna, I.; Rabinowitz, A. D.; Jondorf, W. R.
Food and Cosmetics Toxicology **10** (6) 757-767 (1972) [47 ref. En, fr, de] [Dept. of Pharmacology, George Washington Univ., School of Med., Washington, DC 20005, USA]

Since some nitrosamines are known to be potent carcinogens the possibility of their production by bacterial metabolism in the intestine was investigated. Factors affecting dimethylnitrosamine formation when rat intestinal contents were incubated anaerobically at pH 7.0 with sodium nitrite and ^{14}C-labelled dimethylamine in the molecular proportion 4:1 under various conditions were studied. Factors considered included: effects of neomycin, riboflavin, variation in the vol. of rat caecal suspensions, and concn. of the preservative sodium nitrite. Overall yields of nitrosamine were found to be enhanced by increasing the nitrite levels in the system. VJG

6 G 305
[Conference of the Northern Working Group of the Food Chemistry Section of the Chemical Society in the German Democratic Republic.] Tagung des Arbeitskreises 'Nord' des Fachverbandes Lebensmittelchemie der Chemischen Gesellschaft in der DDR.
German Democratic Republic, Chemische Gesellschaft
Mitteilungsblatt der GDCh-Fachgruppe Lebensmittelchemie und Gerichtliche Chemie **24** (7) 129-136 (1970) [De]

Resumes are given of papers delivered at the Conference, held in Kühlungsborn in April 1970, and include: Determination and hygienic evaluation of surface active agents on items in contact with food, by B. Trost & W. Raffke; Industrial contamination of foods with carcinogenic hydrocarbons, by R. Engst & W. Fritz; Determination of N-nitrosamines in air and in food, by U. Freimuth & E. Glaser; Refractometric determination of fat in vegetable material, by K. S. Grunert, J. Borgwardt, U. Hentrich & C. Franzke (3 ref.); Microbial surface contamination of equipment used for institutional catering, by H Keppler; Microbial nitrite formation in raw spinach and the subsequent lessons for agriculture and the food industry, by H Hawat & M K. Achtzehn; Problems of chemical processing of peeled potatoes, by W. Kerstan (2 ref.); TLC determination of thiuram on lettuce and establishment of the active time, by P. Lohs & H Wetzel (2 ref.); and E
frozen cubic ready meals. W J. St

6 S 607
Non-enzymic in vitro formation of nitrosamines by bacteria isolated from meat products.
Collins-Thompson, D. L.; Sen, N. P.; Aris, B.; Schwinghamer, L.
Canadian Journal of Microbiology 18 (12) 1968-1971 (1972) [14 ref. En, fr] [Res. Lab., Health Protection Branch, Dept. of Nat. Health & Welfare, Ottawa, Canada]

The strains of bacteria used in this study were isolated from bologna batter, bacon, and a fermented sausage, and included strains of Pseudomonas fluorescens, Ps. aeruginosa, Pediococcus cerevisiae, Micrococcus sp., Staphylococcus aureus, Microbacterium thermosphactum, Lactobacillus sp., Streptococcus faecalis, Str. faecium, and Str. lactis; 3 strains of Escherichia coli obtained in pure culture were also tested. The organisms were tested for their ability to form nitrosamines with nitrate and nitrite and secondary amines. The formation in culture of dimethyl- and diethyl-nitrosamine from sodium nitrite and secondary amines was brought about by Streptococcus spp. but not by members of the other genera tested. This formation appeared to be non-enzymic and pH dependent, and may be catalysed by one or more bacterial metabolic products. AA

7 C 171
Nitrosamines: a review.
Sebranek, J. G.; Cassens, R. G.
Journal of Milk and Food Technology 36 (2) 76-91 (1973) [131 ref. En] [Dept. of Meat and Animal Sci., Univ. of Wisconsin, Madison, 53706, USA]

This review draws together recent information and evaluates the problem of nitrosamines in foods. Chemistry of nitroso compounds is discussed and results of several animal studies are cited to emphasize the extreme toxic and carcinogenic potential of some of these compounds. The mechanism of action in tumour development is considered. Although not yet entirely clear, the most acceptable idea involves alkylation of cellular components such as DNA, RNA, and proteins which leads to changes in normal cell growth. Presence of nitrosamines in foods has been documented in several instances but more recent analytical techniques involving gas chromatography and MS have indicated that levels in foods may be lower than previously believed. The potential for formation of nitrosamines from nitrite and secondary amines is discussed, in relation to food before consumption and to formation in the body, particularly the stomach, after consumption. Finally, analytical procedures are reviewed and briefly evaluated and some other possible sources of nitrosamines in the environment are considered. AS

7 C 199
Toxic amines in human food substances.
Lovenberg, W.
Abstracts of Papers, American Chemical Society 165, AGFD 30 (1973) [En] [Nat. Heart & Lung Inst., Nat. Inst. of Health, Bethesda, Maryland 20014, USA]

A number of physiologically active phenylethylamines, indolealkylamines, and imidazolethylamines are found in normal human food substances. These compounds, among which are normal constituents of the body, may be considered toxic by virtue of the relatively large non-physiologic amounts in food, and the possibility that they may be consumed by individuals receiving medication that potentiates the effects of these amines. Amines in foods arise from 2 general sources: they may be normal cellular constituents of plants, e.g., serotonin and dopamine in bananas, or they may be introduced by bacterial action during processing or storage, e.g., tyramine in cheese or histamine in fish. These amines are considered toxic largely because they are vasoactive and may cause dramatic changes in blood pressure. Another important group of toxic amines in current society are those found in plant products that are consumed not for their nutritional value but for their psychic effects. Some examples of these psychoactive amines are: indolealkylamines such as psilocybin and bufotinine in the Mexican mushroom and Cohoba snuff, respectively, and phenylethylamines, such as mescaline, from the Peyote cactus. A number of other psychoactive compounds related to the indolealkylamines are the indole alkaloids found in plant products. Some notable examples are: lysergic acid amides in Morning Glory seeds, harmine in the Caapi plant and ibogaine in the Iboga plant. The roles and dangers of these toxic amines and related compounds in our present-day society will be discussed. AS

7 S 799
[The nitrosamine problem.] Zum Nitrosamin-Problem.
Pfeil, E.; Liepe, H.-U.
Fleischwirtschaft 53 (3) 387-388 (1973) [15 ref. De, en, fr] [Philipps Univ., 355 Marburg, Federal Republic of Germany]

The chemistry, carcinogenic action and occurrence of nitrosamine in foods is reviewed. The use of GLC-MS for reliable determination, the reduction of nitrosamine formation from NO_2 by ascorbic acid and the need for thorough mixing of ingredients to ensure even distribution in meat products are recommended, and the study of curing salt production proposed. RM

7 T 341
[The nitrosamine-problem as seen by a food scientist. Das Nitrosaminproblem aus der Sicht des Lebensmittelchemikers.
Möhler, K.; Mayrhofer, O. L.; Hallermayer, E.
Zeitschrift für Lebensmittel-Untersuchung und -Forschung **150** (1) 1-11 (1972) [56 ref. De, en] [Forschungsanstalt für Lebensmittelchem. der Univ. München, 8050 Freising-Weihenstephan, Federal Republic of Germany]

An extensive review is given of the formation of nitrosamines (some known to be carcinogenic) in foods due to reaction between nitrites and secondary amines. The nitrites may be added directly (e.g. in pickling salts), and it is pointed out that even additions within the legally permitted amounts may be further increased by bacterial reduction of the $NaNO_3$ which is a normal constituents of pickling salts. Literature data are given on the occurrence of volatile secondary amines, principally dimethyl- and diethylamine, in a wide range of foods and the effects of processing. Little information is available on non-volatile secondary amines. Possible reaction mechanisms leading to the formation of nitrosamines in the presence of nitrates, nitrites and amino compounds are discussed, including the influence of pH, temp., nitrite:amine ratio, catalysis by inorganic ions and the importance of microbial production of nitrites. Problems which arise in the determination of volatile nitrosamines due to difficulties of separation from furfurols are outlined, e.g. close similarity of colour reactions with the Griess reagent; use of gas chromatography is probably the best method. Extensive data are tabulated on recorded occurrences of nitrosamines in meat, bacon, sausages, fish, cheese, flour and spinach. ELC

7 U 445
Meat curing and health. Pökeln von Fleisch in der Gesundheitsdiskussion.
Leistner, L.; Linke, H.; Mirna, A.; Wirth, F.
Fleischwirtschaft **53** (3) 349-351 (1973) [En, De, Fr] [Bundesanstalt für Fleischforschung, 8650 Kulmbach, Blaich 4, Federal Republic of Germany]

The conditions of nitrosamine formation in meat products, and recent legislation on nitrate and nitrite addition in a number of countries are reviewed. RM

8 A 358
[Separation of nitrite by ion exchange chromatography and its application to the determination of nitrite in foods.]
Nagai, I.; Reizen, H.
Journal of Hygienic Chemistry (Eisei Kagaku) **18** (5) 329-332 (1972) [3 ref. Ja] [Yamaguchi Prefectural Res. Inst. of Health, 5-67, 2-chome

A method was developed for the separation of nitrite from food products by means of ion exchange column chromatography. The sample is extracted with water at pH 9.0, and the filtrate transferred to a column of Amberlite IRA-410 (Cl form). Nitrite is eluted with a solvent system consisting of methanol and 2% NaCl aqueous solution. Nitrite in the effluent is determined by means of colorimetry using sulphanilamide and N-naphthylethylenediamine. Recovery of added nitrite from various food products was found to be 87-98%. HK

8 C 233
Factors influencing the rate of formation of nitrosomorpholine from morpholine and nitrite: acceleration by thiocyanate and other anions.
Fan, T.-Y.; tannenbaum, S. R.
Journal of Agricultural and Food Chemistry **21** (2) 237-240 (1973) [15 ref. En] [Dept. of Nutr. and Food Sci., Massachusetts Inst. of Tech., Cambridge, 02139, USA]

The kinetics of nitrosation of morpholine, a weak base and possible food contaminant, have been investigated. Temp., pH, and composition of the reaction medium have been explored as experimental variables, and certain anions have been shown to influence strongly the reaction rate. The extent of the effect of thiocyanate, a strong promoter of nitrosation, is dependent upon pH and relative reactant concn. pH-independent rate constants have been calculated for 2 nitrosation mechanisms, and mathematical expressions have been derived which accurately predict overall rates of nitrosation. AS

8 C 250
A method for the detection of traces of nitrosamines using combined gas chromatography and mass spectrometry.
Gough, T. A.; Webb, K. S.
Journal of Chromatography **79**, 57-63 (1973) [13 ref. En] [Lab. of the Govt. Chemist, Stamford Street, London, SE1 9NQ, UK]

A gas chromatograph and high-resolution mass spectrometer, coupled via a membrane separator, are used for the analysis of samples [e.g. food extracts] for traces of nitrosamines. The nitrosamines are detected by parent ion monitoring with a detection limit of 1 mg/l. on injected material. The gas chromatograph incorporates a pressure-programming and peak-cutting device which is described in detail. Overall analysis time is substantially shorter than for isothermal or temp.-programmed runs. AS

8 S 835

Abstracts of papers to be presented at the meeting of the Midwestern Section, ASAS, November 24 and 25, 1972, Chicago, Illinois.

USA, American Society of Animal Science
Journal of Animal Science 35 (5) 1087-1136 (1972) [En]

Effect of pre-chill pork on flaked, formed and sectioned pork products, by K. R. Hansen & R.W. Mandigo (p. 1096-1097); Accelerated pork processing. VI. Fresh-frozen pork chops, by L. C. Hinnergardt, R. W. Mandigo & J. M. Tuomy (p. 1097); Accelerated pork processing. VI. Fresh-frozen pork chops, by L. C. Hinnergardt, R. W. Mandigo & J. M. Tuomy (p. 1097); The effects of processing conditions on trichinae, by J. C. Olson, W. J. Zimmerman, R. E. Rust, F. C. Parrish, Jr. & D. G. Topel (p. 1098-1099); Effect of marbling and doneness on beef palatability, by F. C. Parrish; Jr., R. E. Rust, D. G. Olson & B. E. Miner (p. 1099); Fate of nitrite in cured meat, by J. G. Sebranek, R. G. Cassens & W. C. Hoekstra (p. 1099); Effect of copper on K-stearate desaturation and fatty acid composition in the pig, by E. H. Thompson, C. E. Allen, & R. J. Meade (p. 1099-2000); Effect of liquid feeding oxidation ditch mixed liquor on the palatability of pork, by J. E. Wax, B. G. Harmon & G. R. Schmidt (p. 1100); Starter energy intake and subsequent pig performance and muscle composition, by D. Rousselow, S. Khajarern & D. R. Zimmerman (pp. 1109-1110); Protein and age on performance, carcass traits and digestibility in swine, by T. S. Stahly & R. C. Wahlstrom (p. 1110); and Effects of corn, wheat or wheat plus lysine diets on performance and carcass traits of G-F swine, by A. J. Svajgr, G. M. Miller & L. H. Neagle (p. 1111). JA

8 S 847

[Possible results of prohibiting or reducing the addition of nitrate and nitrite curing salts to meat products. Medical aspects.] Welche Konsequenzen hätte ein Verbot oder eine Reduzierung des Zusatzes von Nitrat und Nitritpökelsalz zu Fleischerzeugnissen? Aus medizinischer Sicht.
Eisenbrand, G.
Fleischwirtschaft **53** (3) 352-354 (1973) [26 ref. De, en, fr] [Deutches Krebsforschungszentrum, Inst. für Expt. Toxikologie und Chemotherapie, 6900, Heidelberg 1, Federal Republic of Germany]

The biological effects of N-nitroso compounds are reviewed with special attention to their organ-specific and transplacental effects. Animal experiments showed in vivo formation of these compounds from non-carcinogenic precursors; combined feeding of nitrite or nitrate and N-nitrosatable precursors (e.g. secondary amines) induced the same tumours as N-nitroso compounds. The reduction of nitrite and nitrate addition to foods including vegetable foods and drinking water is recommended. RM

8 S 848

[Possible results of prohibiting or reducing the addition of nitrate and nitrite curing salts to meat products. Chemical aspects.] Welche Konsequenzen hätte ein Verbot oder eine Reduzierung des Zusatzes von Nitrat und Nitritpökelsalz zu Fleischerzeugnissen? Aus chemischer Sicht.
Mirna, A.
Fleischwirtschaft **53** (3) 357-360 (1973) [27 ref. De, en, fr] [Bundesanstalt für Fleischforschung, 8650 Kulmbach, Federal Republic of Germany]

The effects of reducing nitrite additions to Frankfurter type and dry sausages on colour development and stability and on nitrite content of products were examined. In Frankfurters, contents of residual nitrite and dimethyl nitrosamine (Me_2NA) increased with added nitrite (150 to 1500 ppm) and processing time but decreased with addition of ascorbic acid (550 to 5500 ppm). For satisfactory colour, approx. 50 ppm $NaNO_2$ i.e. 10 g nitrite curing salt was required. Vacuum processing achieved better colour and lower nitrite content in finished product. With dry sausage, normal amount of nitrite curing salt (28 g/kg) produced 3 ppm residual and 24 ppm total nitrite with 73% colour; reducing nitrite to 25% (5.6 g/kg, plus 22.4 g/kg NaCl) produced 2 ppm residual and 9.5 ppm total nitrite with 64% colour; addition of 500 ppm sodium ascorbate or 5000 ppm glucone-δ-lectone produced no further reduction of residual nitrite but increased nitrate. Substitution of nitrite by mixtures of nicotinic acid amide-ascorbic acid-glucose, Na_2SO_3 or glucose oxidase for colour stabilization were unsuccessful.
RM

8 S 1004

Effect of nitrite and nitrate on toxin production by Clostridium botulinum and on nitrosamine formation in perishable canned comminuted cured meat.
Christiansen, L. N.; Johnston, R. W.; Kautter, D. A.; Howard, J. W.; Aunan, W. J.
Applied Microbiology **25** (3) 357-362 (1973) [19 ref. En] [Swift and Co., Res. and Development Center, Oak Brook, Illinois 60521, USA]

Comminuted ham was formulated with different levels of sodium nitrite and nitrate, inoculated with Cl. botulinum, and pasteurized to an internal temp. of 68.5°C. When added to the meat, nitrite concn. decreased, and cooking had little effect on them. Nitrite concn. decreased more rapidly during storage at 27 than at 7°C; however, they remained rather constant at formulated levels throughout the experiment at both incubation temp. The level of nitrite added to the meat greatly influenced growth and toxin production of Cl. botulinum. The concn. of nitrite necessary to effect complete inhibition was dependent on the inoculum level. With 90 Cl. botulinum spores/g meat, botulinum toxin developed in samples formulated with 150 but not with 200 μg of nitrite/g meat. At a spore level of 5000/g, toxin was detected in samples with 400 but not with 500 μg nitrite/g of the product incubated

at 27°C. Al lower concn. of nitrite, growth was retarded at both spore levels. No toxin developed in samples incubated at 7°C. Nitrate showed a statistically significant inhibitory effect at a given nitrite level; however, the effect was insufficient to be of practical value. Analyses for 14 volatile nitrosamines from samples made with varying levels of nitrite and nitrate were negetaive at a detection level of 0.01 µg nitrite or nitrate/g meat. AS

9 R 441

Bacterial production of dimethyl nitrosamine in salted fish.

Fong, Y. Y.; Chan, W. C.

Nature, UK 243 (5407) 421-422 (1973) [8 ref. En] [Dept. of Biochem., Univ. of Hong Kong]

Broth prepared by homogenization of Chinese salted marine fish (crude salt contained nitrate) was sterilized and then incoulated with 10^9 Staphyloccus aureus in 1 ml. The nitrate content of the broth was 40 ppm and the nitrite content 5 ppm. The material was incubated at 37°C and samples analysed for (i) dimethylnitrosamine after 0, 1, 2, 3, 5 and 7 days. A rise in concn. of (i) from 0.1 ppm on day 0 to approx. 0.55 ppm on day 7 was found, thus indicating the importance of the nitrate-reducing staphylococcus originally isolated from fish in the production of (i) from its precursors in the fish. No production of (i) occurred in control sterilized fish. JN

9 S 1104

Nitrate, nitrite, and dimethylnitrosamine in cured meat products.

Panalaks, T.; Iyengar, J. R.; Sen, N. P.

Journal of the Association of Official Analytical Chemists 56 (3) 621-625 (1973) [21 ref. En] [Res. Lab. (Foods), Health Protection Branch, Dept. of Nat. Health and Welfare, Ottawa, Ontario, Canada K1A OL2]

Nitrate, nitrite, and dimethylnitrosamine (DMN) were determined in 197 samples of various kinds of meat products. The average levels of nitrate and nitrite were 181 ppm (range, 0-3467 ppm) and 28 ppm (range, 0-252 ppm), respectively. Trace amounts (2-12 parts/billion) of DMN were present in 57 samples; others were negative. As no mass spectrometric confirmation of the identity of DMN was carried out, the results should be considered as only tentative and not as an absolute proof of the presence of DMN. Except in a few types of meat products, the concentrations of nitrate or nitrite did not correlate with that of DMN detected in the samples. AS

10 C 284

Malignant tumours of liver and lung in rats fed aminopyrine or heptamethyleneimine together with nitrite. [Letter]

Lijinsky, W.; Taylor, H. W.; Snyder, C.; Nettesheim, P.

Nature, UK 244 (5412) 176-178 (1973) [9 ref En] [Carcinogenesis Program, Biol. Div., Oak Ridge Nat. Lab., Tennessee 37830, USA]

The hypothesis that some human cancer might be caused by nitrosamines formed in the gastrointestinal tract from nitrite in the food and secondary or tertiary amines ingested deliberately or incidentallly, was investigated. A long-term feed study was carried out with rats, using nitrite and aminopyrine (an analgesic drug that has been widely used), to discover whether such a combination represents a potential carcinogenic hazard to man. The results of the experiments suggested that the interaction of secondary and tertiary amines with nitrite in the stomach may represent an important facet of the aetiology of cancer in man. The doses of nitrite used did not greatly exceed those encountered in human experience, yet a high tumour incidence was observed after 28-50 wk of treatment, as a result of nitrosamine formation. The readiness with which aminopyrine reacts with nitrite, even at quite low concn., to form dimethylnitrosamine, suggests that taking this drug concurrently with food containing nitrite may represent a very significant carcinogenic hazard. The need for reduction of the residual nitrite in food to the min. and for elimination of nitrite from food when it is not needed for health reasons, is stressed. AA

10 C 285

[A gas chromatographic method for determining nitrosable amines in foods.] Eine gaschromatographische Methode zur Bestimmung nitrosierbarer Amine in Lebensmitteln.

Schweinsberg, E.; Sander, J.; Schweinsberg, F.

Deutsche Lebensmittel-Rundschau 69 (7) 248-252 (1973) [38 ref. De, en, fr] [Hygiene-Inst., Univ. Tübingen, Federal Republic of Germany]

A specific method is given for quantitative determination of nitrosable amines in biological material, utilizing Uno's nitrosation procedure [Japan Analyst (1966) 15, 958-961] with sodium nitrite in acetic acid solution to prepare the N-nitrosamines. These are extracted from the reaction mixture with ether. After concentrating the extract under N_2 the nitrosamines are separated and identified by gas chromatography, and quantitatively analysed by comparing the peak areas with those of amine standard solutions nitrosated in the same way. Sensitivity of the determination is increased by a N specific flame ionization detector. The yields of the nitrosation reaction as well as of the extraction step are determined for a series of secondary amines. The reaction of simple tertiary amines with nitrite under the applied analytical conditions is studied. The application of the method to spinach and fish products is described. AS

10 S 1155

Tissue distribution and metabolism of aflatoxin B_1-^{14}C in broiler chickens.

Mabee, M. S.; Chipley, J. R.

Applied Microbiology 25 (5) 763-769 (1973) [19 ref. En] [Dept. of Poultry Sci., Ohio St. Univ., Columbus, 43210, USA]

The effects of administering low levels of aflatoxin B_1-^{14}C to broiler chickens by crop intubation daily for 14 days were determined. Studies on the distribution of ^{14}C in the blood, selected organs, tissues, and excreta were conducted. No toxic effects were observed in broiler chickens during the 14 days of the experiment. The broiler chickens excreted 90.64% of the ^{14}C administered. Of the ^{14}C retained, 11.04, 9.83, 4.30, 12.52, 31.66 and 30.63% was detected in the blood, liver, heart, gizzard, breast and leg, respectively. Treatment of aqueous extracts for conjugated steroids by treatment with β-glucuronidase revealed that 31.5% of the ^{14}C detected in the aqueous extract was a liberated glucuronide conjugate of aflatoxin M_1-^{14}C. AS

11 M 1362

[Effect of the form of nitrogen on the processing quality of wheat with special consideration of the nitrosamine content.] Einfluss der Stickstofform auf die Verarbeitungsqualität des Weizens unter besonderer Berücksichtigung des Gehaltes an Nitrosaminen.

Buchner, A.; Dressel, J.; Jung, J.

Getreide, Mehl und Brot 27 (7) 221-224 (1973) [17 ref. De] [Landw. Versuchssta., Limburgerhof, Federal Republic of Germany]

The nitrosamine content of the Felix variety of wheat grown in 1 locality was not affected by N fertilizer application in the 0-120 kg/ha range but decreased from approx. 0.08 ppm in DM in 1967 to approx. 0.05 in 1968 and little more than traces in 1969. In the same locality, mean values for nitrosamine contents of 6 varieties of wheat were 0.09 ppm in DM in 1967, 0.05 in 1968 and 0.02 in 1969. SKK

11 S 1256

Effect of frankfurter cure ingredients on N-nitrosodimethylamine formation in a model system.

Fiddler, W.; Pensabene, J. W.; Kushnir, I.; Piotrowski, E. G.

Journal of Food Science 38 (4) 714-715 (1973) [7 ref. En] [USDA E. Regional Res. Lab., Philadelphia, Pennsylvania 19118, USA]

The effect of cure ingredients on the nitrosation of dimethylamine was investigated in a model system containing sodium nitrite. The ingredients used were: sodium chloride, sodium nitrate, glucono-Δ-lactone (GDL), sodium acid pyrophosphate (SAPP), sodium erythorbate (NaEry), sodium ascorbate (NaAsc), ascorbic acid (AscH) and sodium tripolyphosphate (STPP). Under conditions approximating those used in the processing of frankfurters, GDL by itself was found to promote the formation of dimethylnitrosamine (DMNA), whereas reductants reduced the amount formed. Of the reductants, NaAsc or NaEry, in combination with other cure ingredients, have similar inhibitory activity. The use of NaCl, $NaNO_3$, and SAPP had little or no effect on DMNA formation. [See also FSTA 5 (1973) 1S57.] IFT

11 S 1312

[Meat research conference in Yugoslavia: NODA 73.] Fleischforscher-Tagung in Jugoslawien: NODA 73.

Hofmann, K.

Fleischwirtschaft 53 (6) 811-814 (1973) [De] [8650 Kulmbach, Stettiner Strasse 40, Federal Republic of Germany]

The following lectures were given at the meat research conference in Novi Sad (Yugoslavia): The histological structure and ultra structure of muscle, and the chemical composition of muslce fibres, by S. Rahelic; The water-binding capacity of meat, by R. Rede; Structure of reactivity of myoglobin, by D. Saldic-Simic; Composition of curing brine and properties of its components, by B. Skenderovic; The dependence of osmotic diffusion and meat quality on the curing process (injection and immersion), by J. Joksimovic and L. Jovanovic; Effect of time after slaughter on diffusion of brine, by S. Rahelic, L. Jovanovic and B. Skenderovic; Effect of freezing and frozen storage of meat on diffusion of curing brine, by S. Rahelic, V. Pribis and T. Birovljev; Effect of muscle quality on curing, by F. Bucar; Effect of common salt and polyphosphates on muscle protein and water binding capacity of meat, by R. Hamm; Chemical and biochemical aspects of the formation of the curing pigment nitrosylmyoglobin, by K. Möhler; Reactivity of nitrite, nitrate and ascorbic acid in canned cured meat. I. Reaction between meat and the tin can, by T. Kralj; J. Filipovic and M. Susic; Reactivity of nitrite, nitrate and ascorbic acid in canned cured meat. II. Reaction with SH groups, by K. Hofman, M. Susic, D. Manojlovic and G. Nikolic; Nitrite, nitrate, nitrosamine - present state of the problem and its importance for meat processing, by K. Köhler; Modern meat curing processes and their effect on brine diffusion, by M. Stefanovic and S. Tojagic. [Continued in following abstr.] RM

11 S 1381

Nitrosopyrrolidine in cooked bacon.

Fazio, T.; White, R. H.; Dusold, L. R.; Howard, J. W.

Journal of the Association of Official Analytical Chemists 56 (4) 919-921 (1973) [9 ref. En] [Div. of Chem. and Physics, FDA, Washington, DC 20204, USA]

N-Nitrosopyrrolidine has been found in cooked bacon but not in the raw bacon. Levels isolated from 8 commercial brands ranged from 10 to 108 parts/billion (μg/kg). The identity of this nitrosamine has been confirmed by MS AS

11 S 1414
[Model experiments on distribution of nitroso pigments in pig meat 'warm cured' or cured after cooling.]
Pisula, A.; Popiel, J.; Wasilewski, S.
Gospodarka Miesna **25** (5) 19-22 (1973) [14 ref. Pl]

Portions of semimembranosus muscle from normal (non-watery) hams (pH 45 min after slaughter >6.3) were treated as described in FSTA (1970) **2** 7S612 (i) with or (ii) without preliminary holding at 2°C for 72 h. Pickling in 18% brine containing 0.11% $NaNO_2$ lasted 72 h. (iii) samples of the remainder of the muscle in polyethylene film bags were held in a water bath at 70°C for 30 min, and pickled samples were similarly treated after termination of pickling. Contents of nitroso pigments were determined in slices cut after partial freezing from (i)-(iii) samples. Mean contents (as ppm haematin) in (i) and (ii) before pickling were 63.2 and 71.4 respectively; the difference was not significant. Evaluation of the results obtained by examination of consecutive slices showed no significant differences in contents of nitroso pigments between (i) and (ii) after pickling, contents ranging from approx. 10 ppm as haematin in the slice farthest from the brine to approx. 80 ppm in the slice nearest to the brine. [See also following abstr.] SKK

11 S 1415
[Model experiments on distribution of nitroso pigments in cured watery and normal pig meat.]
Mroczek, J.; Wasilewski, S.; Przybylek, K.
Gospodarka Miesna **25** (6) 21-23 (1973) [10 ref. Pl]

In experiments similar to those described in the preceding abstr., contents of nitroso compounds were determined in samples of semimembranosus muscle from 8 (i) normal and 8 (ii) watery hams (defined and treated as in FSTA (1973) **5** 1S138). It was found that contents of nitroso and total pigments were consistently higher in (ii) slices than in corresponding (i) slices, the gradient of nitroso compounds in consecutive slices being similar to that given in the preceding abstr. Because of marked fluctuations, overall differences between (i) and (ii) were not significant, but it is considered that during of (ii) meat might be shortened in relation to the curing of (i) meat. SKK

12 C 333
[Nitrosamines in food.] Über Nitrosamine in der Nahrung. [Review]
Heyns, K.
Getreide, Mehl und Brot **27** (8) 249-253 (1973) [26 ref. De] [Inst. für Organische Chem. und Biochem., Univ., Hamburg. Federal Republic of Germany]

12 C 341
An evaluation of the alkali flame ionisation detector and the Coulson electrolytic conductivity detector in the analysis of N-nitrosamines in foods.
Palframan, J. F.; MacNab, J.; Crosby, N. T.
Journal of Chromatography **76** (2) 307-319 (1973) [44 ref. En] [Lab. of the Govt. Chemist, Cornwall House, Stamford Street, London SE1 9NQ, UK]

A comparison is made of the performance characteristics of 2 dissimilar N detectors. The various parameters influencing the specificity and sensitivity of these detectors are discussed and experience gained in their use for the analysis of foods for traces of nitrosamines is described. Only slight differences in the sensitivities of the 2 detectors were found but the Coulson electrolytic conductivity detector was more selective and less disturbed by small changes in operating parameters, and hence is considered the more suitable for routine use in this field of analysis. A flow diverting system is described which enables the thermionic detector to be used both with chlorinated solvents and injection volumes of hydrocarbon solvents >2 µl. AS

12 C 342
Formation of N-nitrosamines from several amines and nitrite at elevated temperatures.
Warthesen, J. J.; Hildrum, K. I.; Scanlan, R. A.; Bills, D. D.; Libbey, L. M.
Abstracts of Papers, American Chemical Society **166**, AGFD 120 (1973) [En] [Dept. of Food Sci. & Tech., Oregon St. Univ., Corvallis, 97331, USA]

Several commonly occurring amines were reacted with sodium nitrite at elevated temp. The reaction mixtures were extracted with dichloromethane and the extracts were analysed by GLC and MS. The reaction of the amino acids lysine and ornithine with nitrite under conditions of high temp. and low moisture produced N-nitrosopiperidine and N-nitrosopyrrolidine, respectively. N-nitrosopiperidine was also identified as a reaction product of cadaverine and nitrite. Spermine and spermidine when reacted with nitrite under mild conditions in buffered solution yielded an unsaturated propyl-butyl N-nitrosamine and traces of N-nitrosopyrrolidine. AS

12 S 1498
Potential precursors of N-nitrosopyrrolidine in cooked bacon.
Huxel, E. T.; Bills, D. D.; Scanlan, R. A.; Hildrum, K. I.; Libbey, L. M.
Abstracts of Papers, American Chemical Society **166**, AGFD 121 (1973) [En] [Dept. of Food Sci. & Tech., Oregon St. Univ., Corvallis, 97331, USA]

The possibility of producing N-nitrosopyrrolidine from several compounds was investigated. The compound to be tested and sodium nitrite were heated in a system designed to simulate the frying of fatty foods containing

nitrosoproline, pyrrolidine, spermidine, proline and putrescine in yields of 2.6, 1.0, 1.0, 0.4 and 0.04% theoretical, respectively. N-nitrosopyrrolidine was not produced from glutamine, glutamic acid and hydroxyproline. N-nitrosopyrrolidine was formed when dry samples of L-proline, glycyl-L-proline, L-prolyglycine, and pyrrolidine were heated with nitrite at 170°C for 2 h. Collagen samples were heated with sodium nitrite in buffered solution at pH 4.6, 6.2 and 9.0 and dried at temp. of 120, 145, 170 and 195°C for 2 h. 3 observations were noted in the aqueous samples: (i) only the pH 6.2 samples produced N-nitrosopyrrolidine at 120°C, (ii) small amounts of N-nitrosopyrrolidine were produced at 145°C, (iii) in the temp. range 145° to 195°C there were large increases in the amounts of N-nitrosopyrrolidine produced. The dry collagen samples produced N-nitrosopyrrolidine only at 195°C. The identity of N-nitrosopyrrolidine was confirmed by GLC coupled with MS. AS

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